Illinois State Water Survey

WATER RESOURCES BUILDING • MAIL: BOX 232, URBANA, ILLINOIS 61801 • AREA CODE 217
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Subject: Technical Letter 27 February 1978
Operational Prediction of Severe Weather

Probabilities for various types of severe weather (thunder, hail, tornadoes, and heavy raindays) have been determined as a function of the maximum daily cloud top height observed by weather radars. The probabilities are based on data collected during March through August, 1971-1973, and in a 25,000 mi^2 (66,000 km^2) area in central Illinois. [The data and analysis were described by R. C. Grosh in *Relationships between Severe Weather and Echo Tops in Central Illinois,* published in Preprint Volume, Tenth Conference on Severe Local Storms, AMS, Boston, 1977.]

The probability of a particular type of severe weather on a day can be determined from the attached figure in the following manner. First, determine the maximum echo height observed in the area. Use this number on the abscissa and move upward on the graph until the line of interest is intersected (move downward if using metric units). The probability can then be found on the ordinate scale on the left. For example, if the maximum echo top is 40,000 ft (12.2 km), the probability of having hail in the area is 40%, whereas the probability of a tornado is about 6%.

Note the following items:

1) Data on damage by straight line winds were not available, and hence damaging wind probabilities were not considered.

2) 'Severe hail' was defined as a day on which 10% or more of the cooperative substation observers of the National Weather Service reported hail in central Illinois. There were nine days that met this criterion in 1971-1973, or about 15% of the total days with hail. These severe hail days include most of the annual hail damage.

3) 'Severe thunder' was defined as a day when 70% or more of the cooperative substation observers reported thunder. Most damaging lightning occurs on these days (13 in 1971-1973) which represented 5% of the total thunder days.

The key range in echo top heights for 'very severe' weather events appears to be 50,000 to 60,000 ft (15.2 to 18.3 km). Above 60,000 ft (18.3 km) the probability of occurrence of the most severe weather types increases rapidly.

One application of this information is to planned weather modification. The percent of cloud seeding opportunities (echo days) which would be missed by not seeding on days with tops observed (or correctly forecast) to be equal to or greater than a given height can be determined in the following table. For example, a decision to not seed clouds on days with a maximum echo ≥50,000 ft would exclude 16% of all spring and summer rain days.

PERCENT OF RAIN DAYS WITH TALL ECHOES

	Maximum echo top height, feet				
	≥60,000	*≥55,000*	*≥50,000*	*≥45,000*	*≥40,000*
Spring[x]	0	1	3	8	12
Summer[xx]	3	10	30	47	62
Spring + Summer	1	5	16	26	36

[x]Spring = March, April, and May
[xx]Summer = June, July, and August

We hope this information will be helpful to you.

Very truly yours,

Ronald C. Grosh

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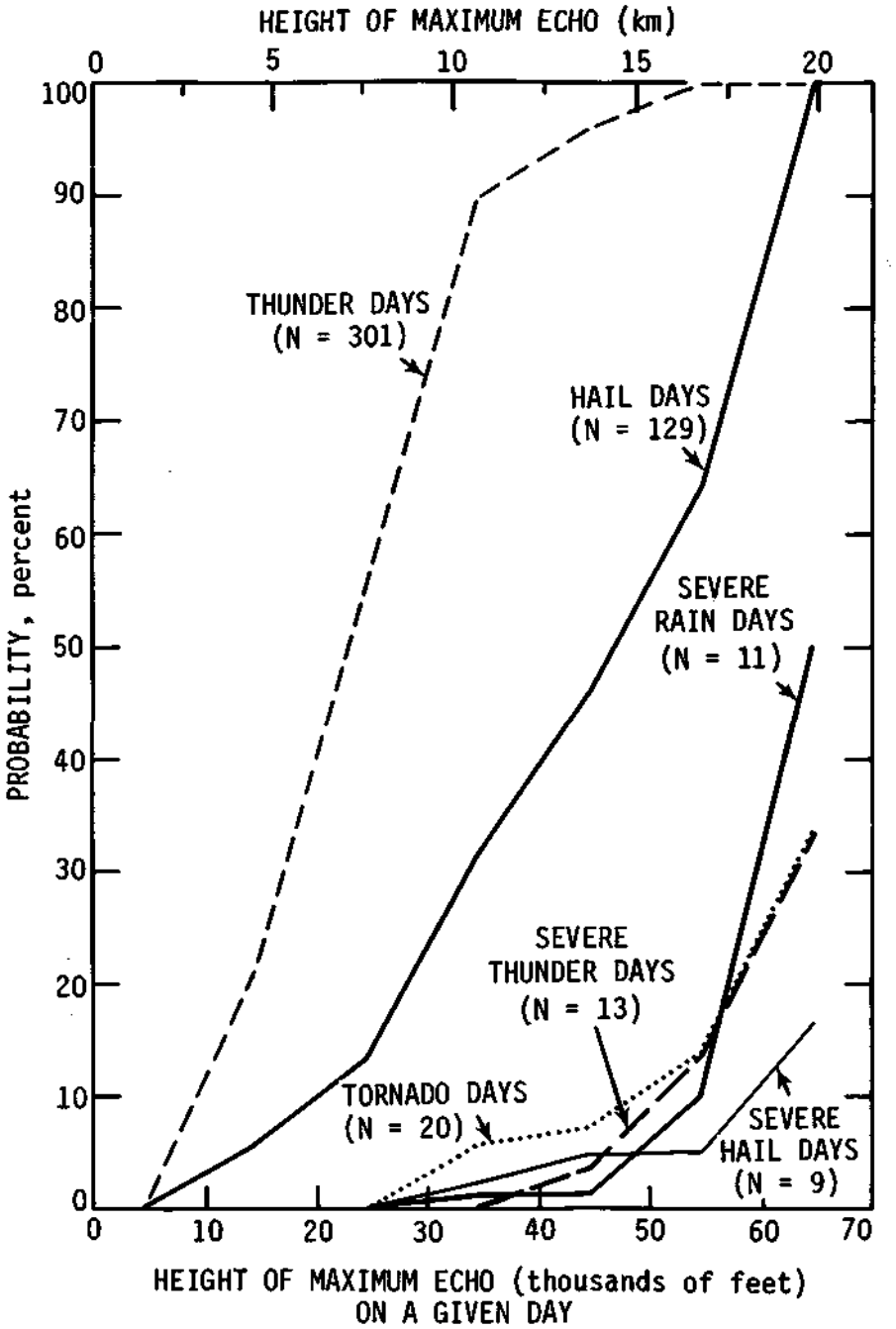

Figure 1. Daily severe weather probabilities as a function of maximum radar echo top heights for spring and summer